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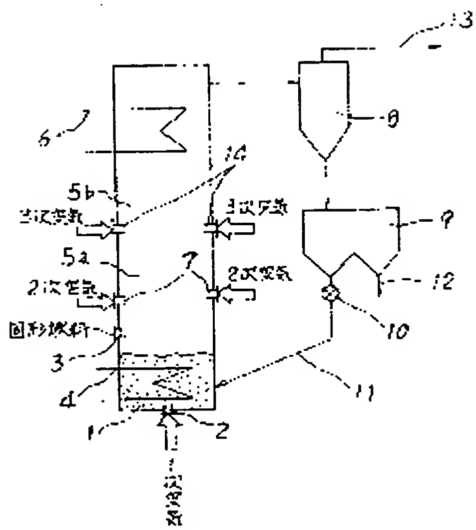
(54) FLUIDIZED-BED COMBUSTION

(57)Abstract:
PURPOSE: To restrain the generation of NOx by providing a secondary air supply port, as well as a third air supply port in a free board of a fluidized combustion furnace so as to specify the air ratio of a primary air inside a fluidized bed relative to a theoretical air volume.
CONSTITUTION: The input of primary air is adjusted by a control device such that the air ratio relative to a theoretical air volume in a fluidized bed 1 becomes about 0.6W0.8. Since the reduction atmosphere inside the fluidized bed 1 is in the range of about 0.6W0.8, green gas is caused to generate, and a part of this green gas is caused to burn when secondary air is input through a secondary air supply port 7 made open near a lower free board 5a provided downstream of the fluidized bed 1. In addition, third air is input through a third air supply port 14 made open near an upper free board 5b provided downstream of the fluidized bed 1 so as to allow the remaining green gas to burn, thus accomplishing combustion of green gas at the upper free board 5b. The air ratio relative to a theoretical air volume after the input of third air is adjusted to become about 0.1 or more. The volume of NOx to be generated becomes minimum when the air ratio of primary air relative to a theoretical air volume is in the range of 0.6W0.8.



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FLUIDIZED BED COMBUSTION METHOD

Background of the Invention

1. Field of the Invention

The present invention relates to a fluidized bed combustion method in which a generation amount of NOx is low and a combustion efficiency is high.

2. Description of the Related Art

A conventional technique will be described below with reference to Fig. 6. In Fig. 6, first air is supplied from a first air supply port opened on a bottom of a fluidized bed 1 having fluid materials, such as sand, limestone and the like, and the fluid materials are fluidized. Then, they are combusted by supplying solid fuels, such as coal and the like, from a fuel supply port 3. A temperature of the fluidized bed 1 is controlled by sending water or vapor into a heat transfer pipe 4 placed inside the fluidized bed 1. Also, a convective heat transfer unit 6 is installed in a free board 5. Then, water or vapor is supplied to it so that the thermal energy of exhaust gas is re-collected. By the way, in order to suppress the NOx generation amount and the exhaust of CO, second air is supplied from a second air

supply port 7. Usually, in order to suppress the CO generation, the fluidized bed 1 is driven under a condition that an air ratio to a theoretical air amount through first air is about 1.0. This reason is as follows. That is, since the fluidized bed combustion is carried out at a relatively low temperature of 800 to 900 ℃. Thus, a temperature of the free board 5 is a low temperature between 500 and 700 ℃. If the solid fuel is combusted in the fluidized bed 1 at a low air ratio of 1.0 or less, the generated CO is not perfectly combusted even by the second air. Thus, this brings about a trouble that CO is exhausted. For this reason, the actually driving condition has the limitation that the air ratio to the theoretical air amount through the first air is dropped to about 1.0 in the fluidized bed 1. Hence, the fluidized bed does not become at a state of reductive atmosphere. As a result, the NOx generation amount becomes vast (150 to 250 ppm (0.6 % conversion)).

By the way, unburned ashes dispersed from the fluidized bed are collected by a cyclone 8 and the like, and stored in a hopper 9. A part of the unburned ashes collected in order to improve the combustion efficiency is circulated in the fluidized bed 1 by an unburned ash

supplier 10 and a circulation piping 11 at a recycle ratio of 0.1 to 0.5 kg/kg coal. However, the other ashes are exhausted from an ash exhaust port 12 to system exterior. 直訳

Separation combustion exhaust gas of unburned components in the cyclone 8 is exhausted from a cyclone outlet 13 to the system exterior. 日本文?

The combustion method in such a conventional fluidized bed typically has the properties as follows:

(1) NOx Generation Amount : 150 to 250 ppm
(0.6 % Conversion)

(2) Combustion Efficiency : 90 to 95 %

The above-mentioned convention fluidized bed combustion method has the following problems.

(1) The NOx generation amount is high such as 150 to 250 ppm (0.6 % conversion).

(2) The combustion efficiency is low such as 90 to 95 %.

The present invention is accomplished in view of the above mentioned circumstances. Therefore, an object of the present invention is to provide a fluidized bed combustion method in which a generation amount of NOx is low and a combustion efficiency is high.

Summary of the Invention

The present invention provides a fluidized bed combustion method characterized in that a method of combusting solid fuels, such as coal, oil coke, oil shale and the like, in a fluidized bed includes the steps of:

(1) supplying a first air from a first air supply port opened on the fluidized bed so that an air ratio to a theoretical air amount in the fluidized bed becomes about 0.6 to 0.8;

(2) supplying a second air from a second air supply port opened on a free board on a downstream side from the fluidized bed so that an air ratio to a theoretical air amount after the supply of the second air becomes about 0.8 to 1.0;

(3) supplying a third air from a third air supply port opened on the downstream side from the second air supply port of the free board so that an air ratio to a theoretical air amount after the supply of the third air becomes about 1.0 or more; and

(4) re-circulating, inside the fluidized bed, unburned ash dispersed from the fluidized bed.

The third air supply port is formed in the free board of the fluidized bed combustion method, in addition to the conventional second

air supply port, and the air ratio to the theoretical air amount through the first air in the fluidized bed is set to about 0.6 to 0.8. Consequently, the inside of the fluidized bed is set at the reductive combustion state in which the air is insufficient. Thus, the NOx generation is suppressed. The unburned gas generated in the fluidized bed is partially combusted by supplying the second air from the second air supply port opened in the free board on the downstream side from the fluidized bed, and it becomes at a temperature of 900 to 1100 ℃. Even after the supply of the second air, the air ratio to the theoretical air amount is about 0.80 to 1.0, which implies the reductive atmosphere. Moreover, the high temperature of 900 ℃ or more leads to the NOx reduction and the decomposition reaction of NH_3, HCN, in this region. After that, the third air is supplied from the third air supply port opened on the downstream side from the second air supply port of the free board. Thus, the unburned CO is combusted, and the combustion is completed.

The re-circulation of the unburned ash dispersed from the fluidized bed not only improves the combustion efficiency but also

enables the inside of the fluidized bed to be at the state of the stronger reductive atmosphere by supplying unburned carbon into the fluidized bed. Consequently, this provides the effect of the drop in the NOx.

As the temperature in the fluidized bed becomes lower, the NOx amount generated in the fluidized bed can be suppressed. Thus, the lower temperature is desired from the viewpoint of the suppression of the NOx generation amount.

Brief Description of the Drawings

Fig. 1 is a view explaining a fluidized bed combustion method of a first embodiment of the present invention;

Fig. 2 is a graph illustrating a relation between an air ratio through first air and an NOx generation amount;

Fig. 3 is a graph illustrating a relation between an NOx generation amount and an air ratio after a supply of second air, and a free board temperature.

Fig. 4 is a graph illustrating a relation between a recycle ratio and an NOx generation amount and a combustion efficiency;

Fig. 5 is a graph illustrating a relation between a temperature inside a fluidized bed

and an NOx generation amount; and

Fig. 6 is a view explaining a conventional fluidized bed combustion method.

Description of the Preferred Embodiments

A fluidized bed combustion method of a first embodiment of the present invention will be described below with reference to Fig. 1.

In Fig. 1, the portions having the same symbols as those of Fig. 6 indicate the portions having the same functions as those of Fig. 1. 6 ?
In Fig. 1, first air is supplied from a first air supply port 2 in a bottom of a fluidized bed 1 having fluid materials (sand, limestone and the like), and the fluid materials are fluidized. For them, solid fuels such as coal and the like are supplied from a fuel supply port 3. The supply amount of the first air is adjusted by a controller (not shown) so that an air ratio to a theoretical air amount in the fluidized bed 1 is about 0.6 to 0.8.

A temperature in the fluidized bed 1 is kept at 800 to 1000 ℃ by adjusting a liquid supply amount to the heat transfer pipe 4 installed within the fluidized bed 1.

The fluidized bed 1 is the reductive atmosphere in which the air ratio to the theoretical air amount is about 0.6 to 0.8.

Thus, unburned gas is generated. However, a part of this unburned gas is combusted by the second air supplied from a second air supply port 7 opened in the vicinity of a lower free board 5a on a downstream side from the fluidized bed 1. Consequently, a temperature of the lower free board 5a becomes about 900 to 100 ℃. Incidentally, the air ratio to the theoretical air amount in this portion is adjusted to about 0.8 to 1.0 by the air amount supplied from the second air supply port 7.

Moreover, in order to combust the remaining unburned gas (mainly, CO), third air is supplied from a third air supply port 14 opened in the vicinity of an upper free board 5b on the downstream side from the fluidized bed 1. Then, the combustion is completed in the upper free board 5b.

By the way, by adjusting the supply amount of the third air, the air ratio to the theoretical air amount after the supply of the third air is adjusted to about 1.0 or more.

Combustion exhaust gas is cooled by a convective heat transfer unit 6, and separated from the unburned ash by the cyclone 8, and then discharged into atmosphere from a cyclone outlet 13. The unburned ash separated by the

cyclone 8 is stored in the hopper 9. After that, at a cycle ratio of 1 or more, it is returned through an unburned gas supplier 10 and a circulation path 11 to the fluidized bed 1. Also, the ash corresponding to the ash amount in the coal supplied into the system is exhausted from an ash exhaust port 12 of the hopper 9 to the system exterior.

By the way, Fig. 2 shows a graph illustrating the relation between the air ratio to the theoretical air amount through the first air and the NOx generation amount. As evident from the graph shown in Fig. 2, as the air ratio to the theoretical air amount through the first air is made lower, the NOx generation amount is dropped. Then, it has the lowest value in the range of the air ratio between 0.6 and 0.8. If the air ratio through the first air is made much lower, the unburned gas is increased, and the combustion rate of the unburned gas in the free board is increased to thereby increase the NOx generation amount. For those reasons, the air ratio to the theoretical air amount through the first air in the fluidized bed 1 is adjusted to about 0.6 to 0.8.

Fig. 3 shows a graph illustrating the relation between the NOx generation amount and

the air ratio to the theoretical air amount after the supply of the second air when the first air ratio is set to 0.7, and the free board temperature.

As evident from the graph shown in Fig. 3, since the air ratio after the supply of the second air is adjusted to 0.8 to 1.0, the temperature of the free board in the reductive atmosphere is increased, and the NOx generation amount is dropped.

Also, Fig. 4 shows a graph illustrating the relation between the recycle ratio of the unburned ash and the NOx generation amount and the combustion efficiency. As evident from the graph of Fig. 4, the increase in the recycle ratio drops the NOx generation amount, and increases the combustion efficiency. By the way, when the recycle ratio is 1.0 or more, its effect is substantially saturated. Thus, the recycle ratio is desired to be 1 or more.

Moreover, Fig. 5 shows a graph illustrating the relation between the temperature inside the fluidized bed and the NOx generation amount. As evident from the graph of Fig. 5, the drop in the temperature of the fluidized bed decreases the NOx generation amount. However, the excessive drop in the

temperature of the fluidized bed causes the combustion efficiency to be made lower. Thus, the temperature of the fluidized bed is desired to be 800 to 1000 ℃.

As mentioned above in detail, according to the method in this embodiment, the NOx generation amount is extremely dropped as compared with that of the conventional technique, and the combustion efficiency is improved.

Advantageous Effects of the Invention

According to the fluidized bed combustion method of the present invention, the following effects are provided.

(1) The NOx generation amount is dropped.

It is 100 ppm (O_2 6%) or less,

in a case of usual coal.

(2) The combustion efficiency is improved.

It is about 95 to 99 %.

What is claimed is:

A fluidized bed combustion method characterized in that a method of combusting solid fuels, such as coal, oil coke, oil shale and the like, in a fluidized bed includes the steps of:

(1) supplying a first air from a first air supply port opened on said fluidized bed so that an air ratio to a theoretical air amount in said fluidized bed becomes about 0.6 to 0.8;

(2) supplying a second air from a second air supply port opened on a free board on a downstream side from said fluidized bed so that an air ratio to a theoretical air amount after the supply of the second air becomes about 0.8 to 1.0;

(3) supplying a third air from a third air supply port opened on the downstream side on said second air supply port of said free board so that an air ratio to a theoretical air amount after the supply of the third air becomes about 1.0 or more; and

(4) re-circulating, inside said fluidized bed, unburned ash dispersed from said fluidized bed.

イクル比1以上でその効果がほぼ飽和するためリサイクル比を1以上とするのが好ましい。

さらに、第5図に流動床内温度とNOx発生量との関係を表わすグラフを示す。第5図のグラフから明らかなように流動床温度の低下によりNOx発生量が低下する。しかし、流動床温度が低下しすぎると、燃焼効率が低下するため流動床温度は800～1000℃が好ましい。

以上、詳述したように本実施例の方法によれば、NOxの発生量が従来に比べ格段と少なくなり、また燃焼効率が向上する。

〔発明の効果〕

本発明の流動床の燃焼方法によればつぎの効果を奏する。

(1) NOxの発生量が低下し、通常の石炭で100ppm(0.6%)以下となる。

(2) 燃焼効率が向上し95～99%程度となる。

4.図面の簡単な説明

第1図は、本発明の1実施例の流動床燃焼方法の説明図、第2図は1次空気による空気比とNOx発生量との関係を表わすグラフ、第3図は2次空気投入後の空気比とNOx発生量およびフリーボード温度との関係を表わすグラフ、第4図はリサイクル比とNOx発生量および燃焼効率との関係を表わすグラフ、第5図は流動床内温度とNOx発生量との関係を表わすグラフ、第6図は従来の流動床燃焼方法の説明図である。

1…流動床、2…1次空気供給口、3…燃料投入口、4…伝熱管、5a…下部フリーボード、5b…上部フリーボード、6…対流伝熱部、7…2次空気供給口、8…サイクロン、9…ホッパ、10…未燃灰供給器、11…循環管路、12…灰抜き出し口、13…サイクロン出口、14…3次空気供給口。

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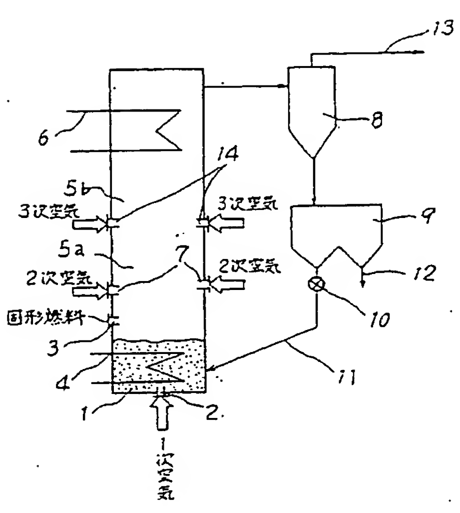
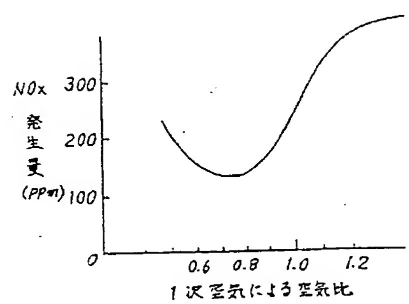
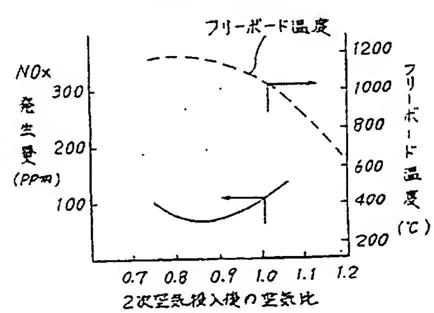
第1図



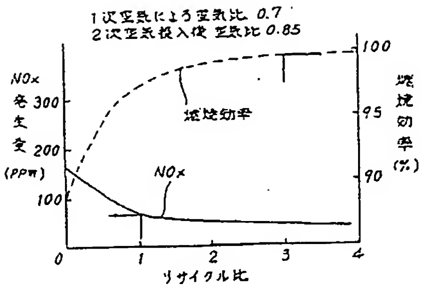
第2図



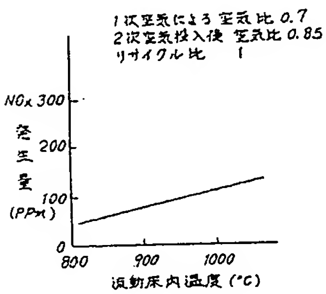
第3図



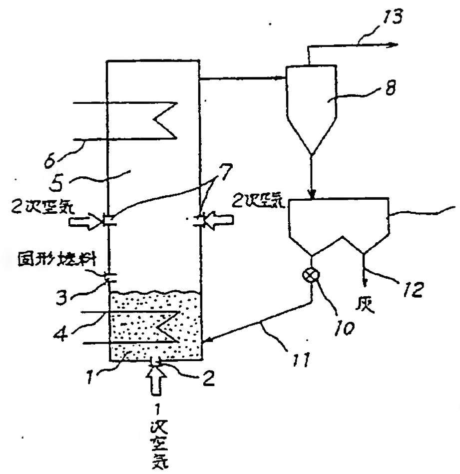
第4図



第5図



第6図



第1頁の続き

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